tech briefs

Westinghouse Savannah River Company

PrecipiPHOS™ Metal Treatment Method

at a glance

- Treats metals throughout a contaminated site
- Safe and easy to use
- Enhances microbial growth
- Uses byproduct of microbial digestive process
- Less expensive then traditional methods
- Effective at greater depths
- U.S. patent pending

for more information

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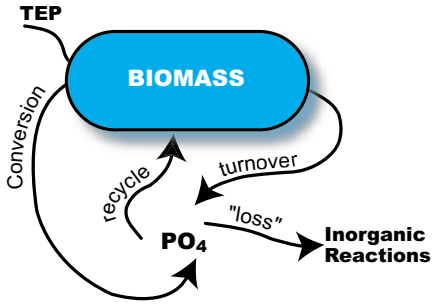
New method immobilizes metals *in situ*

A new method of phosphate-amended bioventing or biosparging provides a cost-effective, controllable alternative to other methods of remediating sites contaminated with metals. The new method can be used in soil, groundwater, or both and can reach contamination at great depths, both above and below the water table.

The new PrecipiPHOS™ method provides a carbon feed source and a phosphate nutrient for the growth of microbes that in turn produce inorganic phosphates as a byproduct of the digestive process. The inorganic phosphates stabilize the metals through precipitation, co-precipitation, or adsorption. This method is useful in treating dissolved metals, metals sorbed to soils, and radionuclides.



New standards drive added clean up

Groundwater contamination with heavy metals is a significant concern throughout the United States. It is estimated that over 60 percent of CERCLA sites contain heavy metals.

In February 2002, the U.S. Environmental Protection Agency revised the standard for arsenic in drinking water from 50 ppb to 10 ppb. Compliance with the new standard is required by January 2006. As a result, many more sites will require remediation to meet regulatory standards.

Background

Metal contaminants are most often found in large volumes at low concentration. Traditional methods of excavating and removing contaminated soil produce a large volume of waste for disposal. In addition to being costly, excavation can have a detrimental effect on the natural ecology of the site. Also, due to the existence of surface or subsurface structures, such excavation is not always possible.

Likewise, traditional pump-and-treat methods for contaminated groundwater require a costly *ex situ* infrastructure and generate waste that requires disposal.

Therefore, *in situ* stabilization of contaminant metals is an attractive alternative.

Although *in situ* bioremediation has been shown to be effective in the treatment of soil and groundwater contaminated with organics, metal contaminants cannot be destroyed through biodegradation.

Liquid or solid chemical reactants may be used to treat metals *in situ*, but such treatment is often limited by the difficulty in distributing the reactants throughout the contaminated zone. The large amounts of reactants that need to be injected at multiple injection sites increase the cost of this method. At sites with clay-rich soils, injection of liquid or solid reactants may not be viable at all.

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PrecipiPHOS™ Metal Treatment Method

Vapor-phase phosphorus permeates subsurface area

In the PrecipiPHOS method, a gaseous organo-phosphorus nutrient mixture is introduced into the contaminated zone via injection wells. Extraction wells can be added as necessary to draw the gaseous mixture through the zone. Selective placement of the wells can provide three dimensional control of the distribution of the nutrients.

This method can be used to treat metal contaminants over a far greater range of conditions than traditional methods. The method also is useful in treating a contaminated lower aquifer without affecting a clean upper aquifer.

The nutrient mixture also can be placed as a barrier in an aquifer ahead of a moving contaminated plume. As the plume moves through the barrier, metals will be stabilized by phosphate generated by the increased biomass.

Nutrient mixture feeds microbes

Appropriate selection of the organophosphate in the nutrient mixture provides a carbon feed source for microbes in environments that do not contain organic contaminants or naturally occurring carbon. The dispersed nutrients will sustain growth of a biomass throughout the contaminated zone. If needed, exogenous microbes can be introduced with the nutrient mixture.

Microbes convert nutrients to inorganic phosphates

The nutrient mixture provides the biomass with a carbon:phosphorus ratio that includes an excess of phosphorus when compared with the bulk carbon:nitrogen:phosphorus ratio required to grow and sustain the biomass. The biomass therefore produces "waste" phosphorus as a metabolic product in the form of inorganic phosphates.

Because the nutrient mixture enhances microbial growth throughout the contaminated zone, the zone is effectively permeated with the biomass. As a result, the inorganic phosphates also permeate the contaminated zone.

Inorganic phosphates immobilize metals

The dissolved inorganic phosphates immobilize metals through precipitation, co-precipitation, or adsorption to a variety of indigenous minerals. Some metals will precipitate as relatively insoluble phosphate compounds. For example, phosphate will interact to precipitate lead, iron, manganese, calcium, and aluminum. Other metals will co-precipitate with these compounds. For example, chromium will coprecipitate with iron phosphate. The adsorption of phosphate onto geothite enhances the subsequent adsorption of cadmium. Cadmium also can be stabilized by ion exchange with calcium in phosphate minerals.

PrecipiPHOS is non-toxic and harmless

The nutrient mixture is non-toxic and poses little harm to the environment. Once the contaminants have been treated, the nutrient addition is terminated, and the enhanced biomass quickly returns to its native state.

While phosphate can be harmful in very high concentrations, treatment by the PrecipiPHOS method does not create harmfully high concentrations.

Related PHOSter® method has proven effective

The injection and dispersion of vapor-phase phosphorous has been shown to be effective in enhancing the bioremediation of organic contaminants. A related invention, known as the PHOSter method, won a prestigious R&D 100 Award and has accelerated the rate of bioremediation of organics at over 50 sites. The PrecipiPHOS method may be used in conjunction with the PHOSter method to treat sites containing both organic compounds and metals.

Partnering opportunity

Westinghouse Savannah River Company (WSRC) has filed a U.S. patent application on the PrecipiPHOS method. U.S. Patents 5,480,109 and 5,753,109 have been issued on the related PHOSter method.

The method should prove effective for remediating contamination caused by industrial operations such as machining, plating, and smelting and contamination associated with mill tailings, ash piles, and coal piles.

WSRC invites interested companies with proven capabilities in this area of expertise to develop commercial applications for this process under a cooperative research and development agreement or a licensing agreement.

Interested companies will be requested to submit a business plan setting forth company qualifications, strategies, activities, and milestones for commercializing this invention. Qualifications should include past experience in the commercial uses of similar processes, reasonable schedule for commercial process launch, an established customer base, and evidence of sufficient financial resources for process development and launch.

Technology transfer

WSRC is the managing contractor of the Savannah River Site for the U.S. Department of Energy. WSRC scientists and researchers develop technologies designed to improve environmental quality, support international nonproliferation, dispose of legacy wastes, and provide clean energy sources.

WSRC is responsible for transferring technologies to the private sector so that these technologies may have the collateral benefit of enhancing U.S. economic competitiveness.